CLAIMS

WE CLAIM:

1. A microelectromechanical system (MEMS) analog isolator, comprising:

a substrate;

an element supported from the substrate for movement between a first and second position with respect to the substrate, where at least a portion of the element between a first and second location on the element is an electrical insulator to electrically isolate the first and second locations from each other;

an actuator attached to the first portion of the element to receive an input electrical signal and exert a force dependent on the input electrical signal urging the element toward the second position;

a control element attached to the element to exert a force dependent on the displacement of the element toward one of the first position and the second position; and

a sensor assembly communicating with the second portion of the element to provide an output electrical signal dependent on movement of the element between the first position and the second position.

2. The MEMS analog isolator of claim 1 wherein the control element is a spring and the sensor assembly includes a sensor providing the analog output electrical signal.

3. The MEMS analog isolator of claim 1 wherein the control element is a second actuator attached to the element to receive a feedback electrical signal and exert a force dependent on the feedback electrical signal urging the element toward the first position; and including

wherein the sensor assembly including a sensor indicating a location of the element with respect to a null position and an error detector receiving the output electrical signal to generate the feedback electrical signal so as to tend to restore the element to the null position and wherein the output electrical signal is derived from the feedback signal.

4. The MEMS analog isolator of claim 1 wherein the control element further includes a third actuator attached to the element to receive a second feedback signal and exert a force dependent on the second feedback electrical signal urging the element toward the second position;

whereby more complex feedback control of the element may be accomplished.

5. The MEMS analog isolator of claim 3 wherein the error detector produces a binary electrical feedback indicating a position of the beam with respect to a null location between the first and second positions and further including a pulse width demodulator circuit evaluating the duty cycle of the feedback signal to produce the output electrical signal.

6. The MEMS analog isolator of claim 1 wherein the actuator is selected from the group consisting of: an electrostatic motor, a Lorenz-force motor, a piezoelectric motor, a thermal-expansion motor, and a mechanical-displacement motor.

7. The MEMS analog isolator of claim 1 wherein the control element is selected from the group consisting of: an electrostatic motor, a Lorenz-force motor, a piezoelectric motor, a thermal-expansion motor, a mechanical-displacement motor, and a mechanical spring.

8. The MEMS analog isolator of claim 1 wherein the sensor is selected from the group consisting of a capacitive sensor, a piezoelectric sensor, a photoelectric sensor, a resistive sensor, or an optical switching sensor.

9. The MEMS analog isolator of claim 1 wherein the element is a beam attached to the substrate for sliding motion between the first and second positions.

10. The MEMS analog isolator of claim 8 wherein the beam moves with respect to the substrate along a longitudinal axis and including flexing transverse arm pairs attached at longitudinally opposed ends of the beam to extend outward therefrom to support the beam with respect to the substrate.

11. The MEMS analog isolator of claim 9 wherein the flexing transverse arms attached to the substrate at points proximate to the beam and where the flexing transverse arms include:

(i) cantilevered first portions having first ends attached to the beam and second ends attached to an elbow portion removed from the beam; and

(ii) cantilevered second portions substantially parallel to the first portions and having first ends attached to the substrate and second ends attached to the elbow portion;

whereby expansion of the first portion is offset by substantially equal expansion of the second portion so that the amount of stress in the beam can be controlled.

12. The MEMS analog isolator of claim 9 wherein the flexing transverse arms attach to the substrate through a spring section allowing angulation of the end of the transverse arm with respect to the substrate.

13. The MEMS analog isolator of claim 9 wherein the beam and transverse arms are symmetric across a longitudinal axis.

14. The MEMS analog isolator of claim 9 including further a magnetic field crossing the beam and wherein at least one flexing transverse arm pair is conductive to receive an electrical signal and exert a force dependent on the electrical signal urging the beam toward position.

15. The MEMS analog isolator of claim 9 including transverse extending primary capacitor plates attached to the beam and extending outward from the beam proximate to secondary capacitor plates.

16. The MEMS analog isolator of claim 14 wherein an effective area of the primary capacitor plates is equal across the longitudinal axis of the beam.

17. The MEMS analog isolator of claim 14 wherein the capacitor plates attach to the beam between the attachment points of at least two of the flexing transverse arm pairs.

18. The MEMS analog isolator of claim 14 wherein the primary capacitor plates are positioned with respect to the secondary capacitor plates so as to draw the primary capacitor plates toward the secondary capacitor plates on one side of the beam while to separate the primary capacitor plates from the secondary capacitor plates on the other side of the beam with a given motion.

19. The MEMS analog isolator of claim 14 wherein the primary capacitor plates are positioned with respect to the secondary capacitor plates so as to draw the primary capacitor plates toward the secondary capacitor plates on both sides of the beam with a given motion.

20. The MEMS analog isolator of claim 1 wherein the beam includes first and second micro-machined layers, the first of which is insulating to provide the portion of electrical insulator in a region where the second layer is removed.

21. The MEMS analog isolator of claim 1 wherein the portion of electrical insulator of the beam is between the actuator and the controlling device.

22. The MEMS analog isolator of claim 1 wherein the portion of electrical insulator of the beam is between the controlling device and the sensor.

23. An isolated circuit module comprising:

a substrate;

a plurality of interconnected solid-state electronic devices formed on the substrate into an integrated circuit having analog input and output points;

a mechanical analog isolator also formed on the substrate and electrically attached to at least one of the integrated circuit input and output points, the mechanical analog isolator including:

a substrate;

an element supported from the substrate for movement between a first and second position with respect to the substrate, where at least a portion of the element between a first and second location on the element is an electrical insulator to electrically isolate the first and second locations from each other;

an actuator attached to the first portion of the element to receive an input electrical signal and exert a force dependent on the input electrical signal urging the element toward the second position;

a control element attached to the element to exert a force dependent on the displacement of the element toward the first position;

a sensor assembly communicating with the second portion of the element to provide an output electrical signal dependent on movement of the element between the first positions.

24. The isolated circuit module of claim 23 wherein the actuator of the mechanical analog isolator is attached to at least one output point of the integrated circuit whereby the output electrical signal provides an isolated output for the at least one output point.

25. The isolated circuit module of claim 23 wherein the sensor of the mechanical analog isolator is attached to at least one input point of the integrated circuit whereby the output electrical signal provides an isolated input to at least one output point.

26. The MEMS analog isolator of claim 1 including further a second sensor at the first portion of the element to provide a second output electrical signal indicating movement of the element to the second position, the second output electrical signal being electrically isolated from the output electrical signal.

27. The MEMS analog isolator of claim 26 including further a second actuator at the second portion of the element to receive a second input electrical signal and exert a force dependent on the second input electrical signal urging the element toward the second position.